Zootaxa 4658 (2): 201–222
https://www.mapress.com/j/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4658.2.1
http://zoobank.org/urn:lsid:zoobank.org:pub:13429195-C5D1-4F10-9C3F-EBC6CDF89D8C

Amblyseiinae of New Zealand (Acari: Phytoseiidae): redescriptions, rediscoveries, new records, new combinations and keys to species

MIN MA[1], QING-HAI FAN[2] & ZHI-QIANG ZHANG[3,4]*
[1] *College of Agronomy, Shanxi Agriculture University, Taigu, Shanxi, China*
[2] *Plant Health & Environment Laboratory, Ministry for Primary Industries, Auckland, New Zealand*
[3] *Landcare Research, Private Bag 92170, Auckland, New Zealand*
[4] *School of Biological Sciences, The University of Auckland, Auckland, New Zealand*
* *Corresponding author. E-mail: ZhangZ@landcareresearch.co.nz*

Abstract

This paper presents several new additions and changes to the subfamily Amblyseiinae of New Zealand. *Amblyseius lentiginosus* Denmark & Schicha, 1974 is newly recorded in New Zealand and its males and females are redescribed in detail. *Amblyseius obtusus* was recollected and a revised key to New Zealand species of *Amblyseius* is provided. *Proprioseiopsis lenis* (Corpuz & Rimando, 1966) is reported from New Zealand for the first time and its females are described in detail. A key to New Zealand species of *Proprioseiopsis* is also included. A rare species, *Phytoscutus acaridophagus* (Collyer, 1964), was rediscovered and its males and females are redescribed in detail. Three species, two in *Amblyseius* and one in *Proprioseiopsis,* are transferred to the genus *Graminaseius*: *G. bidibidi* (Collyer, 1964) comb. nov., *G. martini* (Collyer, 1982) comb. nov. and *G. exopodalis* (Kennett, 1958) comb. nov. *Graminaseius* has not been previously recorded in New Zealand.

Key words: Mesostigmata, Amblyseiinae, New Zealand, new records, redescriptions, keys

Introduction

The family Phytoseiidae in New Zealand has been reasonably well studied, with 35 species in 13 genera recorded (Collyer 1982; Minor 2008; Sirvid *et al*. 2011; this study). The majority of these species belong to four genera: *Amblyseius* (4 spp.), *Neoseiulus* (8 spp.), *Neoseiulella* (8 spp.) and *Typhlodromus* (5 spp.). In this paper, we add new records to the New Zealand fauna and provide detailed redescripitons of three species.

Amblyseius lentiginosus Denmark & Schicha, 1974 has previously only been reported from Australia (Demite *et al*. 2018). It was recently collected in New Zealand (North Island). We herein provide a redescription of both sexes and we compared our specimens with type material from Australia. We also provide an updated key to the New Zealand species of *Amblyseius*.

Proprioseiopsis lenis (Corpuz & Rimando, 1966) has previously been reported from Australia, Philippines (original description) and Thailand (Demite *et al*. 2018). We present the first report of this species from New Zealand with a detailed redescription of its females. We also provide a key to the New Zealand species of *Proprioseiopsis*.

The genus *Phytoscutus* is represented in New Zealand by a single species, *P. acaridophagus* (Collyer, 1964) (Sirvid *et al*. 2011). It was originally described based on a male specimen by Collyer (1964) who followed Pritchard & Baker's classification system and placed it in the genus *Iphiseius*. Two years later Collyer (1966) described the females and kept the species in *Iphiseius*. Yoshida-Shaul & Chant (1997) transferred the species to *Phytoscutus* and redescribed the female based on a "paratype female" designated by Collyer (1966). Walter (1999) provided a diagnosis of the species based on three females collected from Queensland and Victoria, Australia, and discussed the prey specialisation of some species of *Phytoscutus*. Recently, we obtained two fresh females and re-examined some specimens of Collyer. Here we redescribe the males and females according to the latest standards.

Accepted by B. Halliday: 16 Aug. 2019; published: 22 Aug. 2019

Material and methods

We collected fresh phytoseiid mites and made new permanent slides under a dissecting microscope (Leica MZ6). Previously mounted materials located in the New Zealand Arthropod Collection, Auckland were remounted. Specimens were examined, measured and photographed with the same methods of Ma *et al*. (2016). Measurements are presented as the value from the specimen from which the drawings were made followed by the range in parentheses. All measurement units were presented in micrometres (μm); each measurement shows the average (minimum–maximum) in micrometres. Setal nomenclature follows Evans (1953) and Chant & McMurtry (2007), and the terminology of pore-like structures follows Beard (2001) and Beaulieu & Beard (2018). All specimens (except those borrowed) are deposited in NZAC, Auckland, New Zealand. Institutional acronyms follow Zhang (2018).

Results

Genus *Amblyseius* Berlese, 1914

Amblyseius Berlese, 1914: 143.
Type species: *Zercon obtusus* Koch, 1839, *sensu* Karg, 1960: 440.

Amblyseius lentiginosus Denmark & Schicha, 1974

Amblyseius lentiginosus Denmark & Schicha, 1974: 145.
Amblyseius lentiginosus.—Schicha, 1987: 61.
Amblyseius (*Amblyseius*) *lentiginosus*.—Schicha, 1977: 153.
Amblyseius perlongisetus.—Collyer, 1964: 634; Collyer, 1982: 194; Zhang 2001: 15. (misidentification).

Redescription

Adult female (n=3 from NZ and 1 paratype from Australia; Table 1).

TABLE 1. Comparative measurements (in micrometres) of females of *Amblyseius lentiginosus* Denmark & Schicha, 1974.

Characters	Original description by Denmark & Schicha (1974)	Paratype examined (this study)	NZ material (this study)
Dorsal shield (L)	352–360	401	360–409
Dorsal shield (W)	199–202	222	203–232
j1	30–36	38	31–37
j3	55–58	59	51–56
j4	6	5	4–6
j5	3	4	3–4
j6	7	6	5–8
z2	7–9	9	6–10
z4	6–7	7	6–8
z5	3–4	5	4–5
s4	85–90	98	85–100
J2	7	6	6–7
J5	7–8	8	7–10

...Continued on next page

TABLE 1. (Continued)

Characters	Original description by Denmark & Schicha (1974)	Paratype examined (this study)	NZ material (this study)
Z1	7	7	6–9
Z4	123–130	142	114–134
Z5	203–210	226	186–210
S2	7–9	9	6–9
S4	7–9	8	8–9
S5	7–9	6	5–8
r3	14–16	16	14–16
R1	9–10	11	9–14
Sternal shield (L)	116–130	72	62–66
Sternal shield (W)	101–109	80	81–83
Distance *st5–st5*	80–100	82	91–109
st1	–	34	28–36
st2	–	32	32–34
st3	–	30	30–31
st4	–	29	26–29
st5	–	27	26–28
Ventrianal shield (L)	116–130	126	123–129
Ventrianal shield (W)	101–109	95	92–96
Distance *gv3–gv3*	–	17	16–17
JV1	–	17	15–18
JV2	–	17	15–18
JV4	–	9	10–12
JV5	–	86	79–86
ZV1	–	17	12–16
ZV2	–	16	15–16
ZV3	–	9	10–14
Primary metapodal platelets (L)	–	26	26–29
Primary metapodal platelets (W)	–	7	6–9
Secondary metapodal platelets (L)	–	12	11–10
Secondary metapodal platelets (W)	–	3	3
Spermathecal cervix	–	21–22	20–24
Movable digit	50–51	36	35–38
Pilus dentilis	–	6	8–11
Leg I	399	406	399–430
Leg II	338	333	338–443
Leg III	336	332	342–355

...Continued on next page

TABLE 1. (Continued)

Characters	Original description by Denmark & Schicha (1974)	Paratype examined (this study)	NZ material (this study)
Leg IV	419	426	419–459
Macroseta Ge IV	90–101	139	105–117
Macroseta Ti IV	91–94	107	74–97
Macroseta BTa IV	75–87	83	69–82

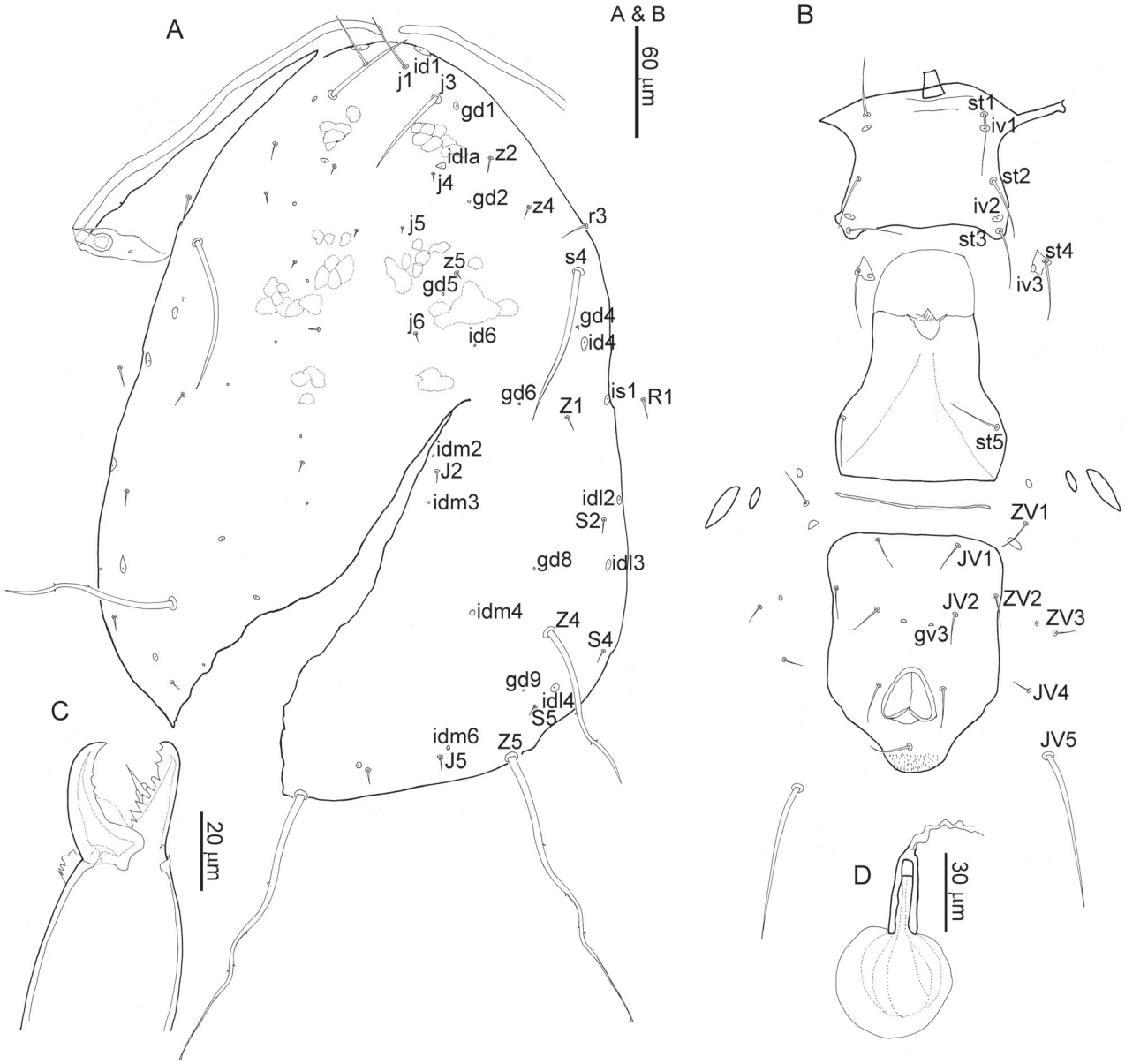

FIGURE 1. *Amblyseius lentiginosus* (female). A. dorsal idiosoma; B. ventral idiosoma; C. chelicera; D. insemination apparatus.

Dorsum (Fig. 1A; Plate 2A). Dorsal shield smooth, nearly oval, with a waist at level of *R1*; 374 (360–409) long, 220 (203–232) wide at level of setae *s4*, bearing 17 pairs of smooth setae except *Z4* and *Z5* (slightly barbed), all minute except *j1*, *j3*, *s4*, *Z4* and *Z5*; *j3* slightly longer than *j1*, extending beyond bases of *z2*; *s4* extending beyond bases of *Z1*; *Z5* whip-like and apically blunt, approximately twice as long as *Z4*; lateral setae *r3* and *R1* smooth, on soft membranous cuticle lateral to dorsal shield, *r3* at level of *z4*. Twelve pairs of visible lyrifissures (*id1*, *id4*, *id6*, *idl1*, *idl3*, *idl4*, *idla, is1*, *idm2*, *idm3*, *idm4* and *idm6*) and seven pairs of gland openings (*gd1*, *gd2*, *gd4*, *gd5*, *gd6*, *gd8*

and *gd9*) present on dorsal shield. Muscle marks visible, mainly between *j3* and *J2*. Peritremes extending forward beyond bases of *j1*. Lengths of setae: *j1* 33 (31–37), *j3* 54 (51–56), *j4* 5 (4–6), *j5* 3 (3–4), *j6* 6 (5–8), *z2* 8 (6–10), *z4* 7 (6–8), *z5* 4 (4–5), *s4* 90 (85–100), *J2* 6 (6–7), *J5* 9 (7–10), *Z1* 7 (6–9), *Z4* 125 (114–134), *Z5* 197 (186–210), *S2* 8 (6–9), *S4* 8 (8–9), *S5* 7 (5–8), *r3* 15 (14–16), *R1* 11 (9–14).

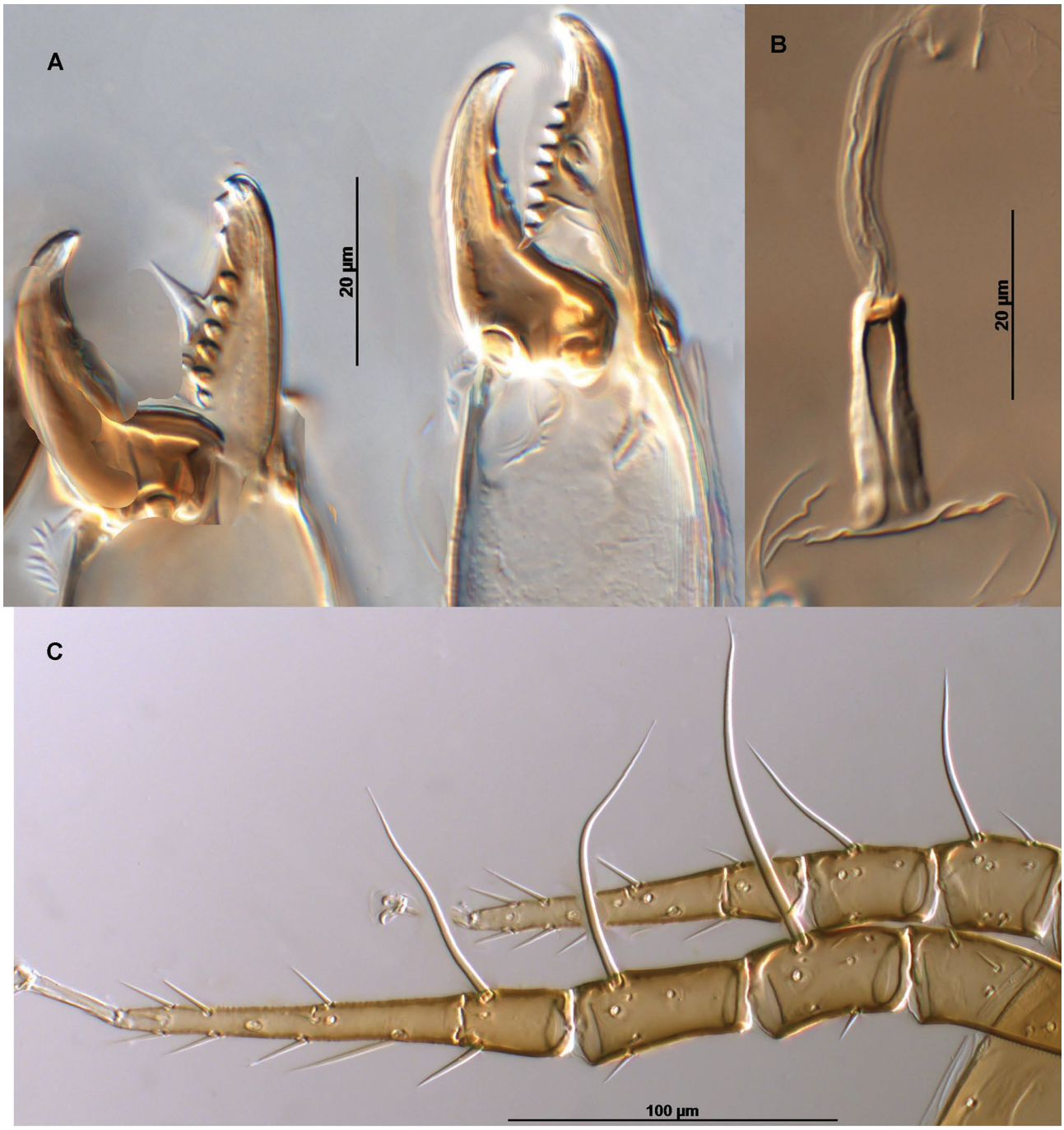

PLATE 1. *Amblyseius lentiginosus* (female). A. chelicera; B. spermathecal; C. leg IV.

Ventral idiosoma (Figs 1B, Plate 2B). Sternal shield smooth, 64 (62–66) long, 82 (81–83) wide, faintly striated at lateral margins, bearing three pairs of setae (*st1*, *st2* and *st3*) and two pairs of lyrifissures (*iv1* and *iv2*); *iv1* posterior to *st1*, *iv2* anterior to *st3*; *st4* and *iv3* on metasternal platelets. Genital shield smooth, distance between *st5*–*st5* 100 (91–109). Lengths of setae: *st1* 33 (28–36), *st2* 33 (32–34), *st3* 30 (30–31), *st4* 28 (26–29), *st5* 27 (26–28). A series of horizontal sclerites present between genital and ventrianal shields; a pair of small platelets between *ZV1* and *ZV2*. Ventrianal shield 125 (123–129) long, 94 (92–96) wide at level of *ZV2*, approximately pentagonal, with

three pairs of pre-anal setae (*JV1*, *JV2* and *ZV2*) and a pair of conspicuous elliptical gland openings (*gv3*) posteromedial to *JV2*, distance *gv3–gv3* 16 (16–17); 3 pairs of setae (*ZV1*, *ZV3*, *JV4* and *JV5*) and a pair of lyrifissures on soft cuticle surrounding ventrianal shield; *JV1* close to anterior margin of ventrianal shield. Lengths of setae: *JV1* 17 (15–18), *JV2* 15 (15–18), *JV4* 11 (10–12), *JV5* 81 (79–86), *ZV1* 14 (12–16), *ZV2* 15 (15–16), *ZV3* 12 (10–14). Primary metapodal platelets 27 (26–29) long, 8 (6–9) wide, secondary metapodal platelets 11 (11–10) long, 3 wide.

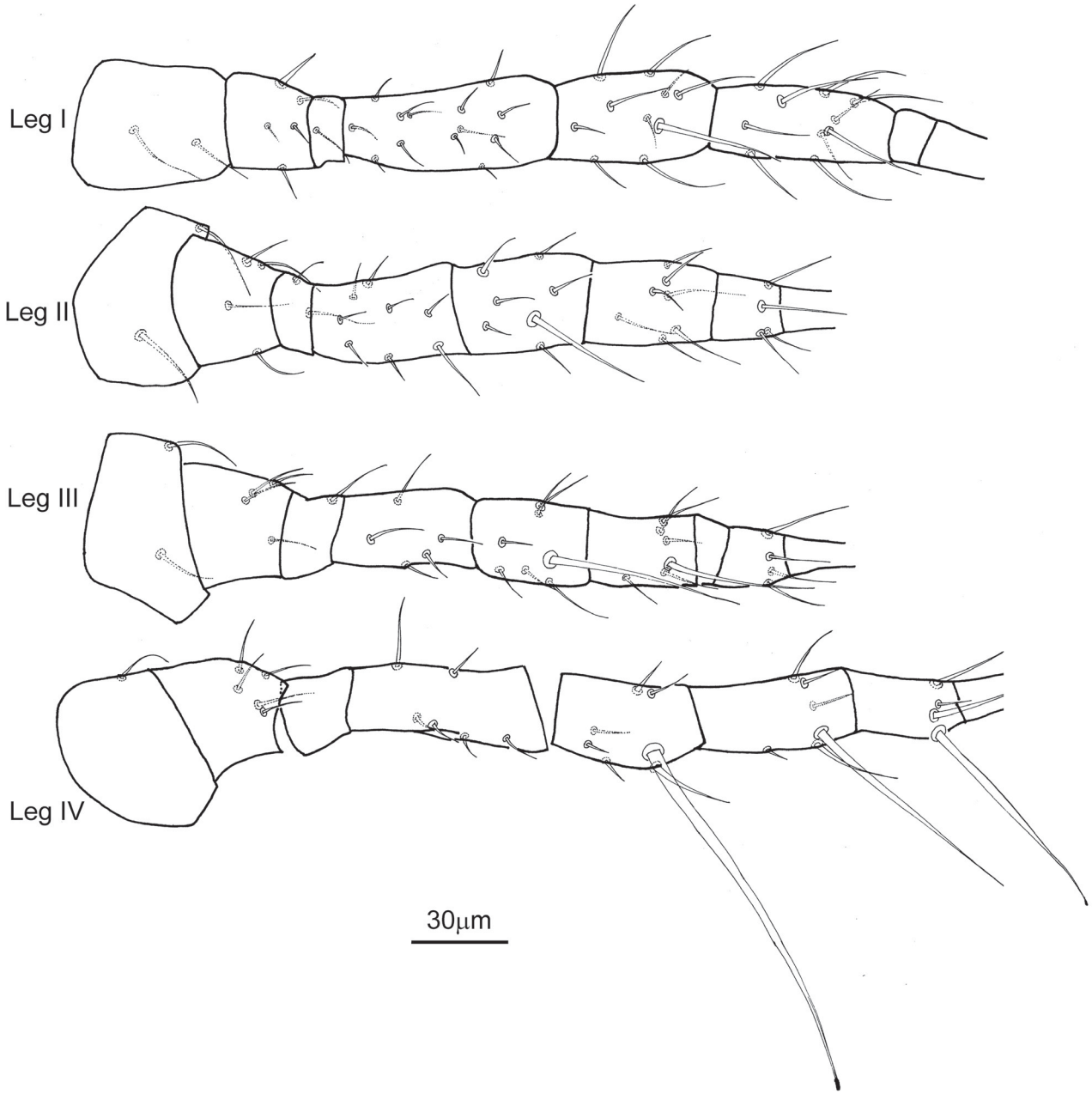

FIGURE 2. *Amblyseius lentiginosus* (female). legs. I–IV.

Spermatheca (Fig. 1D, Plate 1B, Plate 2D): major duct moderately expanded and membranous; minor duct not visible; cervix tube-like, stout, 22 (20–24) long.

Gnathosoma. Chelicera (Fig. 1C, Plate 1A, Plate 2C) with movable digit 37 (35–38) long, bearing three teeth, fixed digit bearing 8–9 stout teeth (two teeth off-set distally plus 6–7 teeth along main axis); pilus dentilis 9 (8–11) long.

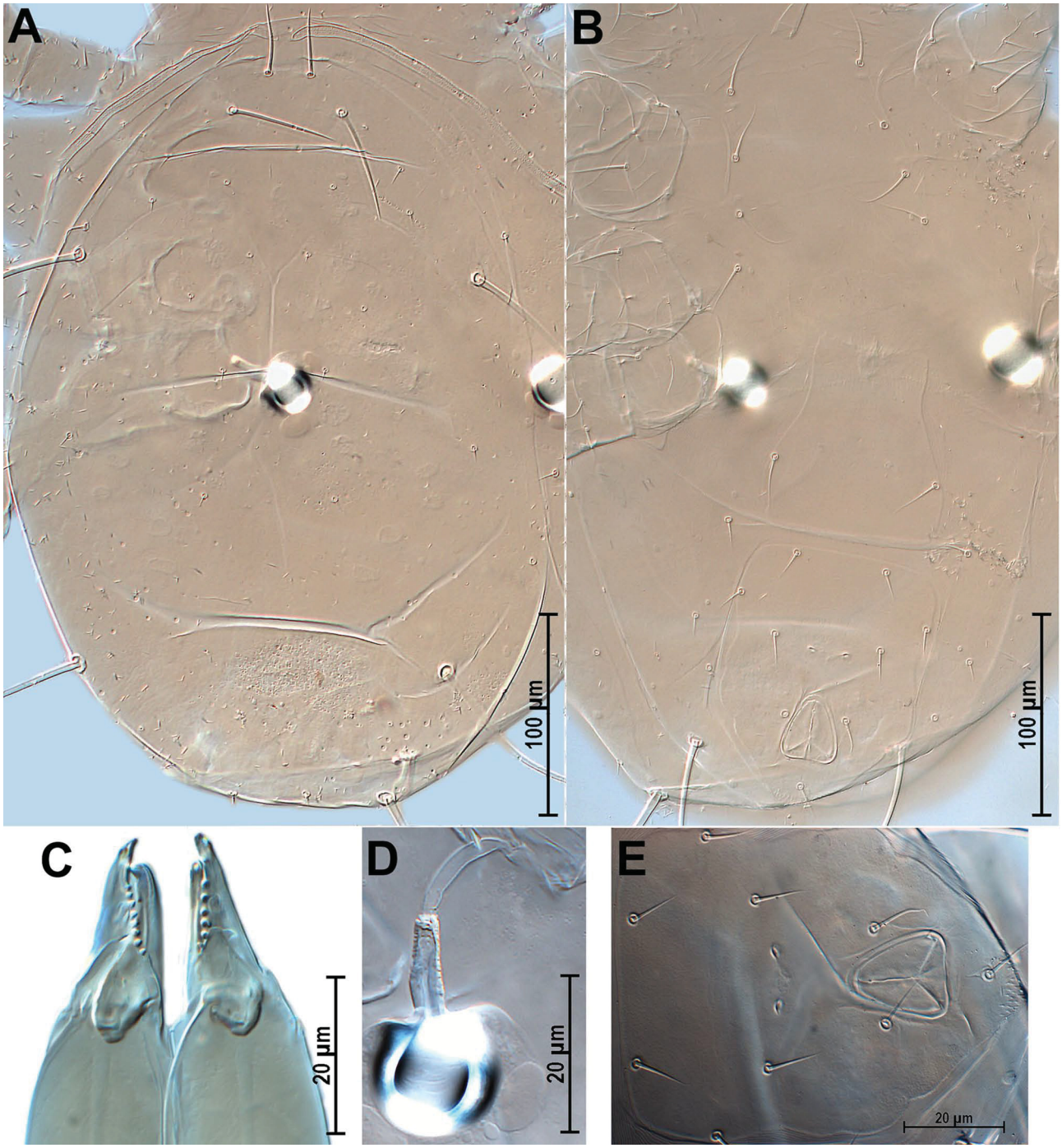

PLATE 2. *Amblyseius lentiginosus* (paratype female). A. idiosoma (dorsal view); B. idiosoma (ventral view). C. Chelicera. D. spermatheca; E. Ventrianal shield.

Legs (Fig. 2, Plate 1C). Leg I 399 (399–430), chaetotaxy (coxa to basitarsus): 0-0/0-0/2-0; 1-0/1-0/2-1; 2-3/1-3/3-2; 2-2/1-2/1-2; 3-1/1-2/1-2; 0-0/0-0/0-0. Genu and tibia each with a macroseta. Leg II 338 (338–443); chaetotaxy: 0-0/1-0/1-0; 1-0/1-0/1-1; 1-3/2-2/1-1; 2-2/0-2/0-1; 1-1/1-1/2-1; 1-1/0-1/0-1. Genu and tibia each with a macroseta. Leg III 336 (342–355); chaetotaxy: 0-0/1-0/1-0; 1-0/1-0/1-1; 2-1/0-2/0-1; 1-1/0-2/1-2; 1-1/1-1/1-2; 1-1/0-0/1-1. Genu and tibia each with a macroseta. Leg IV 419 (419–459); chaetotaxy: 1-0/0-0/0-0; 1-0/1-0/2-1; 1-1/0-2/1-1; 1-1/1-2/1-1; 1-1/1-1/1-1; 0-1/1-1/1-0. Genu, tibia and basitarsus IV each with a blunt-tipped macroseta, 111 (105–117), 86 (74–97), 69 (69–82) long, respectively.

Adult male (n=2).

Dorsum (Fig. 3A). Dorsal shield smooth, nearly oval; 301 (297–306) long, 190 (190–191) wide between *s4*; bearing 19 pairs of setae, all smooth except *Z4* and *Z5* (slightly barbed), *Z5* whip-like and apically blunt, *Z5*>*Z4*>*s4*>*j3*>*j1*. Lateral setae *r3* and *R1* smooth, on dorsal shield; bearing seven pairs of visible lyrifissures (*id2*, *id4*, *id5*, *idm2*, *idm3*, *idm5* and *idl3*) and six pairs of gland openings (*gd1*, *gd2*, *gd4*, *gd5*, *gd6* and *gd9*). Muscle marks visible, mainly between *j3* and *J2*. Peritremes extending forward to bases of *j1*. Lengths of setae: *j1* 23 (22–24), *j3* 44 (42–45), *j4* 4 (4–5), *j5* 5, *j6* 6, *z2* 8 (7–8), *z4* 7(5–7), *z5* 5 (4–5), *s4* 73 (73–74), *J2* 7 (6–7), *J5* 8 (8–9), *Z1* 8 (8–9), *Z4* 98, *Z5* 152, *S2* 10 (9–12), *S4* 6, *S5* 7, *r3* 14 (13–16), *R1* 9.

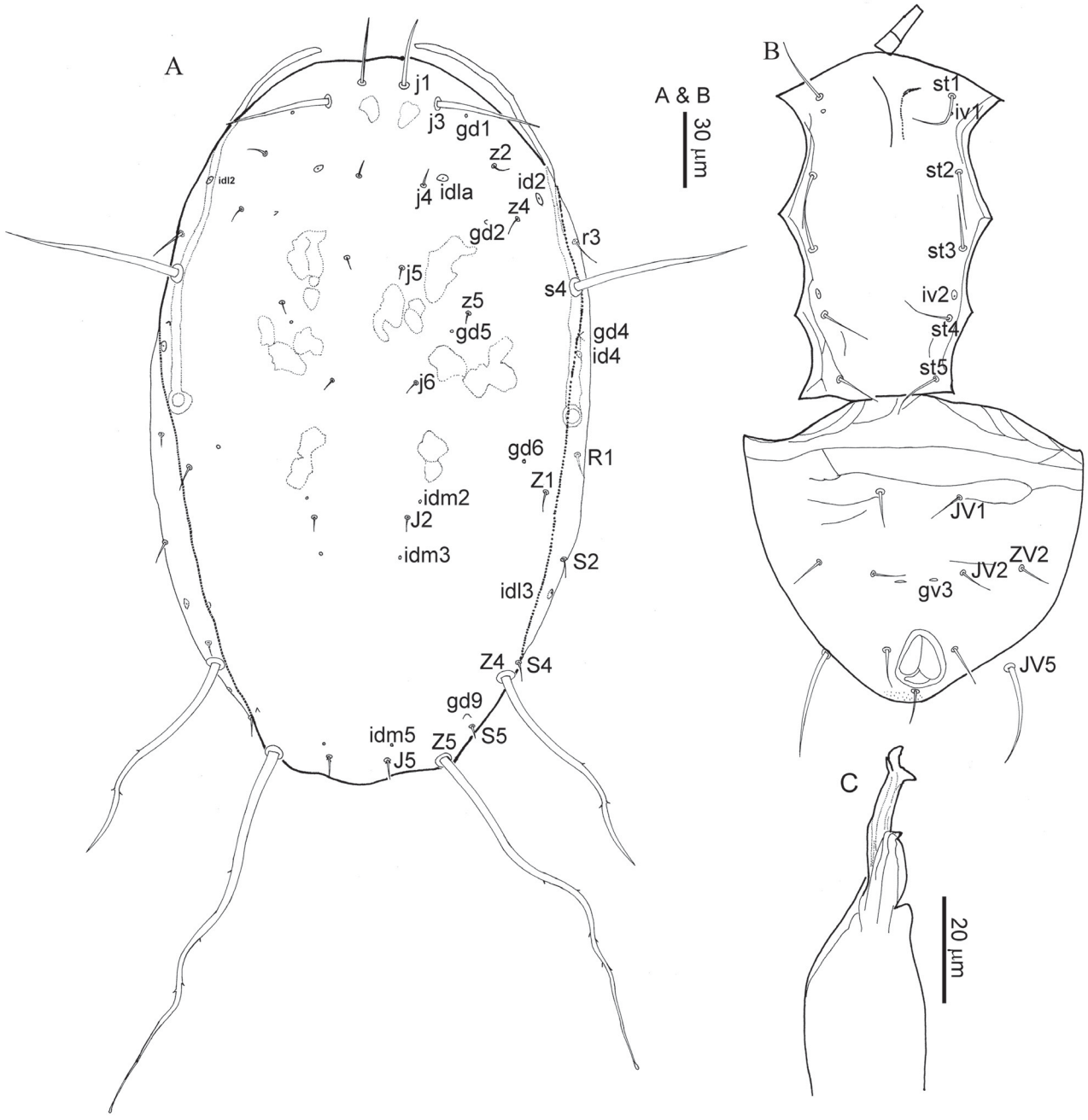

FIGURE 3. *Amblyseius lentiginosus* (female paratype; Australia). A. dorsal idiosoma; B. ventral idiosoma; C. chelicerae.

Ventral idiosoma (Fig. 3B). Sternogenital shield 133 (128–139) long, 72 (68–76) wide, mostly smooth, with few lateral striate; posterior margin nearly straight, bearing five pairs of attenuate setae (*st1*, *st2*, *st3*, *st4* and *st5*) and two pairs of lyrifissures (*iv1* and *iv2*); Lengths of setae: *st1* 26 (25–26), *st2* 22, *st3* 22, *st4* 21 (19–23), *st5* 21 (20–22). Ventrianal shield approximately subtriangular, middle of anterior margin convex and with sparse striae, 130 (129–130) long, 148 (139–156) wide (at widest level), with three pairs of pre-anal setae (*JV1*, *JV2* and *ZV2*); a

pair of para-anal setae (*pa*) and a postanal seta (*po*); a pair of gland openings (*gv3*) medial of *JV2*, distance *gv3–gv3* 18; setae *JV5* on cuticle surrounding ventrianal shield. Lengths of setae: *JV1* 16 (15–16), *JV5* 41 (38–43), *ZV2* 12 (10–14).

Gnathosoma (Fig. 3C). Spermatodactyl L-shaped, small with round heel and straight foot.

Specimens examined: 7 females, 2117 Arapuni Road, Pukeatua 3880, ex. leaves of lavender (*Lavandula spica*, Lamiaceae), 31 August 2017, coll. Qing-Hai Fan (T17_03151C); 1 female [+ *Typhlodromina musero* 1 female; *Typhlodromus* (*T.*) *pyri* 2 females], Kumeu, Auckland, ex. persimmon fruit, May/June 1989, coll. P. Dentener; 2 females, Sharlands Creek Matai Track, Nelson, ex. Silver fern, date and coll. unknown; 7 females, 2 males, Tamaki Campus, Auckland, ex. gorse (*Ulex europaeus*, Fabaceae), 7 November 2017, coll. Chris Winks. 3 females, [+ *Graminaseius bidibidi* 2 females], Tasman, South Island, ex. roadside apple, 10 April 1966, coll. unknown; 2 females, [+ *Neoseiulella novaezealandiae* 1 female; *Neoseiulella nesbitti* 1 female], West Auckland, Oratia, ex. apple, 11 January 1961, coll. Barr; 1 female, 328 Karaka Rd, Drury, NZ Hothouse, ex. capsicum fruit, 18 January 2005, coll. L. Howe. Paratype female (in ASCU, previously BCRI; ASCT00049356), Australia, New South Wales, Bathurst, apple leaves, 28 January 1971, coll. E. Schicha.

Distribution. Australia: Australian Capital Territory, New South Wales, Queensland, Victoria, Tasmania and Western Australia (O'Dowd 1974; Denmark & Schicha 1974; Schicha 1977; James & Whitney 1993; Whitney & James 1996; Demite *et al*. 2018); New Zealand: Auckland, Hamilton, Nelson, Tasman (this paper).

Remarks. We found that Collyer's voucher specimens of *Amblyseius perlongisetus* Berlese, 1916 were consistent with *A*. *lentiginosus* Denmark & Schicha, 1974. This paper presents new descriptions of gland openings and lyrifissures on the dorsal shield, and of legs I–III. This species was originally described from apple trees in New South Wales, Australia (Denmark & Schicha 1974). Schicha (1977) further illustrated the larval and nymphal stages. It is one of the common phytoseiid species on grapevines in temperate southern Australia (James & Whitney 1993; Whitney & James 1996), and O'Dowd (1994) recorded this species from a very different climate zone from the leaf domatia of coffee (*Coffea arabica*, Rubiaceae) in tropical north Queensland, Australia. Both lavender and gorse represent new host plant records for this species.

Key to New Zealand species of *Amblyseius* (females)

1. Ventrianal shield pentagonal, without a narrow waist; cervix thick-walled or decorated with granules 2
- Ventrianal shield vase-shaped, with a narrow waist; cervix wall thin and smooth 3
2. Cervix slender, decorated with granules; *gv3* small and round, obviously posterior to *JV2* . . . . . *A*. *obtusus* (Koch, 1839)
- Cervix stout, without granules; *gv3* larger and elliptical, posteromedial to *JV2* . . . . *A*. *lentiginosus* Denmark & Schicha, 1974
3. Cervix parallel-sided . . . . . *A*. *largoensis* (Muma, 1955)
- Cervix gradually flared toward vesicle. . . . . *A*. *herbicolus* (Chant, 1959)

Notes

Minor (2008) recorded five species of *Amblyseius* from New Zealand: *bidibidi*, *herbicolus*, *largoensis*, *martini* and *perlongisetus,* while Sirvid *et al*. (2011) listed four species i.e. *largoensis*, *martini*, *obtusus* and *perlongisetus*. Other species included in *Amblyseius* by Collyer (1982) have since been transferred to other genera of Phytoseiidae (Minor 2008; Sirvid *et al*. 2011).

Based on the direct examination of the type specimens, we here transfer two species previously known as *Amblyseius* to *Graminaseius*: *Graminaseius bidibidi* (Collyer, 1964) comb. nov. and *A*. *martini* (Collyer, 1982) comb. nov.

Amblyseius obtusus was recorded in New Zealand by Lamb (1952), followed by Spain & Luxton (1971) and Sirvid *et al*. (2011), but overlooked by Collyer (1964; 1982) and Minor (2008). We examined an adult female specimen of this species that had been recently recovered from a sticky board inside a honey bee (*Apis mellifera*) hive on 30 August 2013 (T13_02950) and deposited in the Plant Health & Environment Laboratory, Auckland, New Zealand.

Most specimens previously identified as *Amblyseius largoensis* in NZAC are actually *A*. *herbicolus* according to the broadened concept of *A*. *largoensis* by Collyer (1982). More detailed data will be presented in a separate paper on the ontogeny of *A*. *herbicolus*.

Genus *Phytoscutus* Muma, 1961
Phytoscutus Muma, 1961: 275.
Type species: *Phytoscutus sexpilis* Muma, 1961.

***Phytoscutus acaridophagus* (Collyer, 1964)**
Iphiseius acaridophagus Collyer, 1964: 644.
Iphiseius acaridophagus.—Collyer, 1966: 12; Moraes *et al*., 1986.
Phytoscutus acaridophagus.—Yoshida-Shaul *et al*., 1997: 225; Walter, 1999: 99.

Redescription

Adult female (n=3).

TABLE 2. Comparative measurements (in micrometres) of females of *Phytoscutus acaridophagus* (Collyer, 1964).

Characters	"Paratype" examined by Yoshida 1977	NZ material (this study)
Dorsal shield (L)	437	422–492
Dorsal shield (W)	386	315–390
j1	27	20–27
j3	31	22–42
j4	15	18–20
j5	–	12–14
j6	37	21
z2	24	27–30
z4	48	62–72
z5	10	9–17
s4	130	126–138
J2	23	29–33
J5	13	12–14
Z1	25	47
Z4	116	119–125
Z5	115	110–117
S2	43	48–62
S4	19	15–20
S5	13	14–17
r3	8	6–9
R1	13	12
Sternal shield (L)	20	20
Sternal shield (W)	76	81–83
Distance *st5–st5*	128	111–122
st1	–	26–30

...Continued on next page

TABLE 2. (Continued)

Characters	"Paratype" examined by Yoshida 1977	NZ material (this study)
st2	–	23–24
st3	–	20–26
st4	–	21–24
st5	–	23–26
Ventrianal shield (L)	–	191–215
Ventrianal shield (W)	–	218–239
Distance *gv3–gv3*	–	36–39

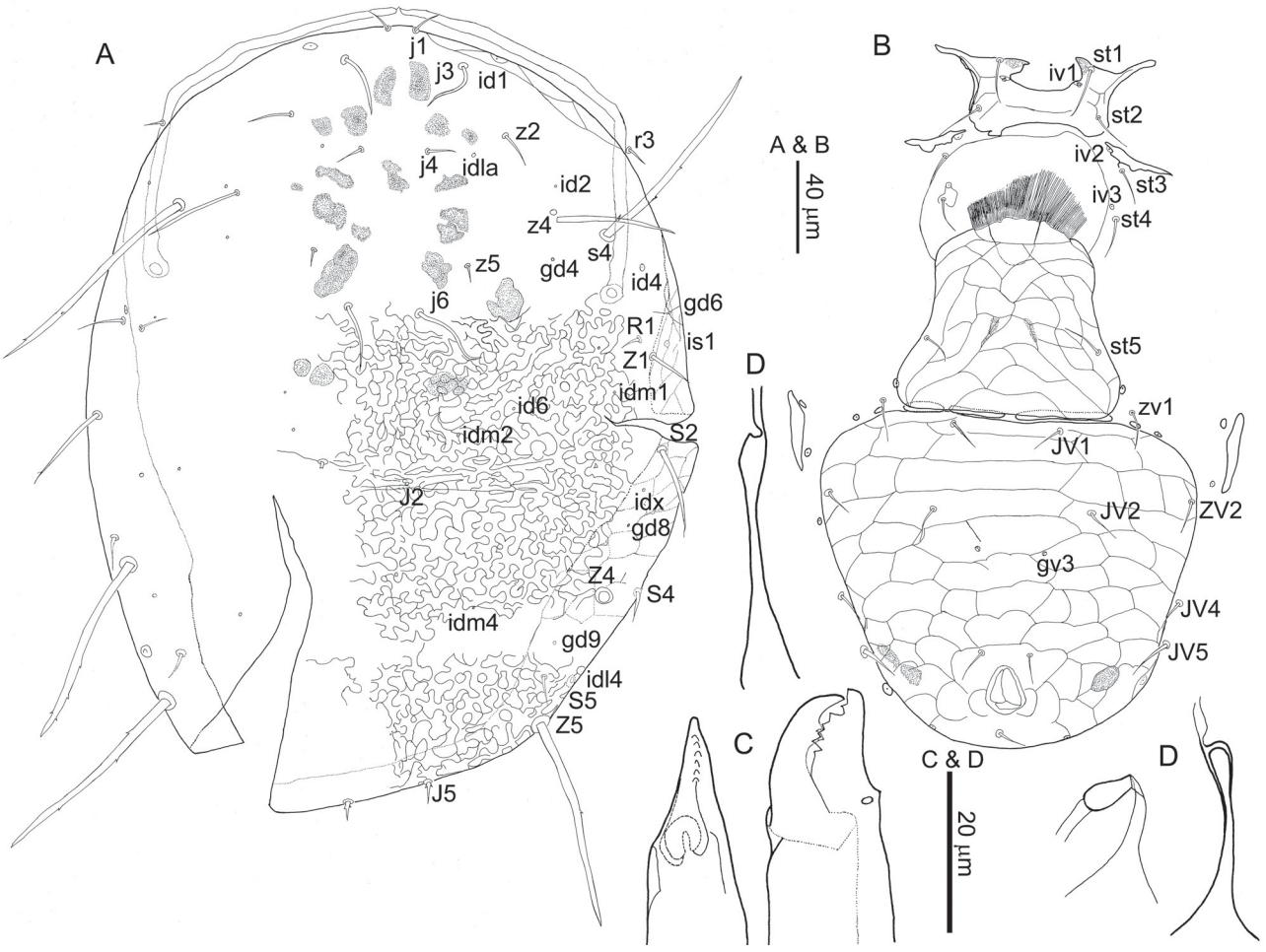

FIGURE 4. *Phytoscutus acaridophagus* (female). A. dorsal idiosoma; B. ventral idiosoma; C. chelicera; D. insemination apparatus.

Dorsum (Fig. 4A, Plate 3A). Dorsal shield nearly rounded, 422–492 long, 315–390 wide at level of setae *s4*; jigsaw-like reticulation present between *j6* and *Z4*, *S5* and *J5*, and marginal areas. Sixteen pairs of setae present on dorsal shield, all smooth except *s4*, *Z4* and *Z5* (barbed), *z4*, *s4*, *S2*, *Z4* and *Z5* longer than others. Lateral setae *r3* and *R1* smooth, on soft membranous cuticle lateral to dorsal shield, *r3* at level of *z2*. Eleven pairs of visible lyrifissures (*id1*, *id2*, *id4*, *id6*, *idx, idl4*, *idla*, *is1*, *idm1*, *idm2* and *idm4*) and four pairs of gland openings (*gd4*, *gd6*, *gd8* and *gd9*) present on dorsal shield. Muscle marks visible, mainly in podosomal areas between *j3* and *j6*. Peritremes extending forward and reaching *j1*. Lengths of setae: *j1* 23 (20–27), *j3* 38 (33–42), *j4* 20 (18–20), *j6* 21, *z2* 29 (27–30), *z4* 66 (62–72), *z5* 12 (9–17), *s4* 132 (126–138), *J2* 30 (29–33), *J5* 12 (12–14), *Z1* 47 *Z4* 122 (119–125), *Z5* 114 (110–117), *S2* 54 (48–62), *S4* 17 (15–20), *S5* 15 (14–17), *r3* 8 (6–9), *R1* 12.

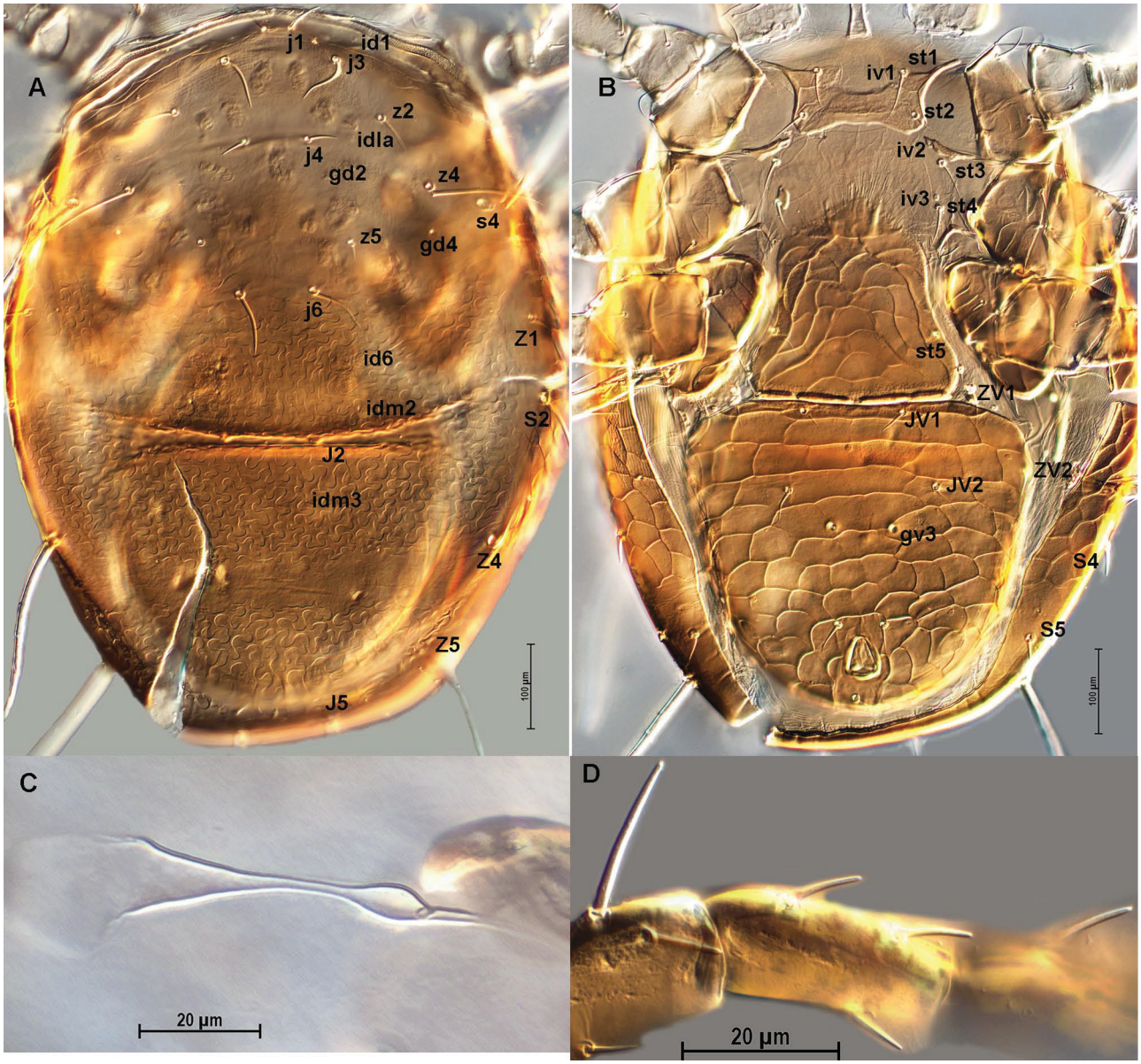

PLATE 3. *Phytoscutus acaridophagus* (female). A. dorsal view of idiosoma; B. ventral view of idiosoma; C. spermatheca; D. leg IV.

Ventral idiosoma (Figs 4B, Plate 3B). Sternal shield 20 long, 81 (81–83) wide, laterally reticulated, anterior margin strongly and irregularly emarginated between first pair of sternal setae (*st1*), extending to level of lyrifissures (*iv1*); posterior margin of sternal shield concave; two pairs of attenuate setae (*st1*, *st2*) and one pair of lyrifissures (*iv1*) on sternal shield; *iv2* adjacent to posterior margin of sternal shield, *st3* on soft cuticle, *st4* and *iv3* on metasternal platelets. Lengths of setae: *st1* 27 (26–30), *st2* 24 (23–24), *st3* 21 (20–26), *st4* 21 (21–24). Genital shield mostly reticulate, 168 (156–177) long, 111 (111–122) wide at level; length of setae *st5* 24 (23–26). Three horizontal sclerites present between genital and ventrianal shields; a pair of small metasteranal platelets between *ZV1* and *ZV2*. Ventrianal shield 200 (191–215) long, 227 (218–239) wide at level of *ZV2*, approximately subquadrate (although weakly tapered and rounded posteriorly), distinctly reticulated, a pair of marginal muscle marks situated lateral to anus, with three pairs of pre-anal setae (*JV1*, *JV2* and *ZV2*; *JV3*, *ZV3* absent) and a pair of small circular gland openings *gv3* posteromedial to *JV2*, distance *gv3–gv3* 38 (36–39). Three pairs of setae (*ZV1*, *JV4* and *JV5*) and three pairs of lyrifissures on soft cuticle surrounding ventrianal shield; *JV1* inserted at anterior margin of ventrianal shield. Primary metapodal platelets 45 (42–47) long, 8 (8–9) wide, secondary metapodal platelets 5 (3–6) long, 3 (2–3) wide.

Spermatheca (Fig. 4D, Plate 3C): major duct narrow, thin, membranous; minor duct not visible; cervix long, dilated basally at junction with atrium, narrowing to form a neck before flaring distally at junction with membranous vesicle, 39 (32–42) long.

Gnathosoma. Chelicera (Fig. 4C) with movable digit 26 long, bearing six teeth, fixed digit 23 (20–24) long, bearing two visible teeth.

Legs (Fig. 6, Plate 3D). Leg I 459 (458–464), chaetotaxy (coxa to basitarsus): 0-0/1-0/1-0; 1-1/1-0/1-1; 3-3/2-2/1-1; 2-3/1-2/0-2; 2-2/1-3/1-1; 0-0/0-0/0-0 respectively. Femur I with three slender macrosetae; genu I with four long and blunt-tipped macrosetae; tibia I with three long and blunt-tipped macrosetae. Leg II 395 (372–438); chaetotaxy: 0-0/1-0/1-0; 1/1-1/1-0; 3-0/1-3/1-2; 0-2/0-2/1-2; 1-1/1-1/1-1; 0-1/1-1/1-0. Femur II with one blunt-tipped macroseta; genu II with four blunt-tipped macrosetae; tibia II with three stout macrosetae; basitarsus II with two stout macrosetae. Leg III 372 (371–377); chaetotaxy: 0-0/1-0/1-0; 1-1/1-0/2-0; 1-2/1-1/0-1; 1-2/0-2/0-1; 1-1/1-2/1-1; 1-1/0-1/0-1. Femur III with four blunt-tipped macrosetae; genu III with five blunt-tipped macrosetae; tibia with three stout macrosetae; basitarsus III with two blunt-tipped macrosetae. Leg IV 492 (474–516); chaetotaxy: 0-0/1-0/0-0; 1-1/1-0/2-0; 0-2/1-1/1-0; 1-2/0-2/1-1; 1-1/0-2/1-1; 1-1/0-1/0-1. Genu IV with four blunt-tipped macrosetae, tibia IV with four blunt-tipped macrosetae, basitarsus IV with two blunt-tipped macrosetae (Plate 3D).

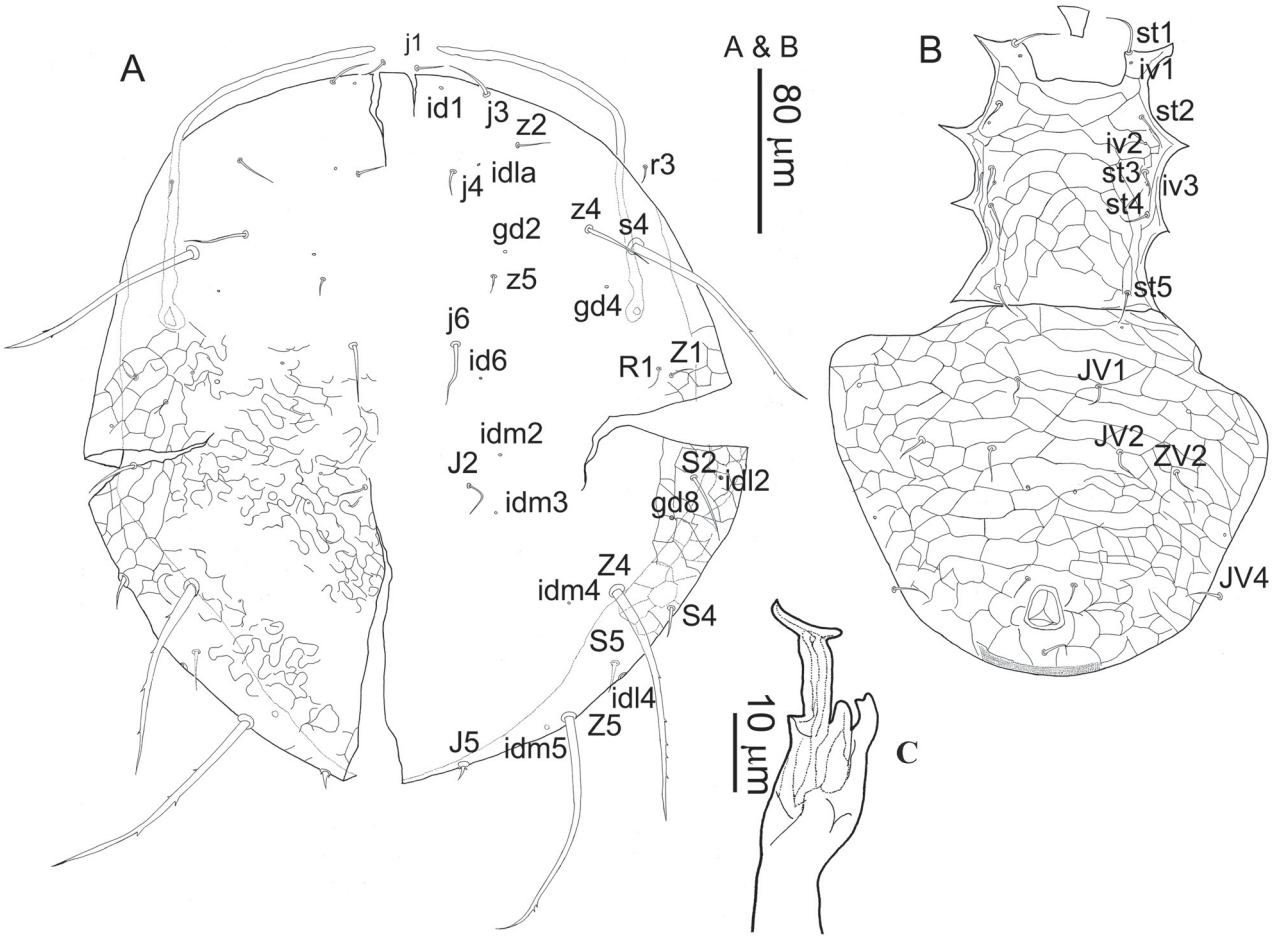

FIGURE 5. *Phytoscutus acaridophagus* (male). A. dorsal idiosoma; B. ventral idiosoma; C. chelicera.

Adult male (n=1).

Dorsum (Fig. 5A, Plate 4A). Dorsal shield nearly rounded, 390 long, 308 wide between *s4*, with jigsaw-like reticulation between *j6* and *Z4*, *S5* and *J5*; with distinct reticulation on lateral areas; bearing 18 pairs of setae, all smooth except *s4*, *Z4* and *Z5* (barbed), *Z5*>*Z4*>*s4*>*S2*. Lateral setae *r3* and *R1* smooth, on soft membranous cuticle lateral to dorsal shield, *r3* at level of *j4*, *R1* usually under dorsal shield on mounted specimen; bearing nine pairs of visible lyrifissures (i*d1*, *id6*, *idl1*, *idl4, idl*a, *idm2, idm3*, *idm4* and *idm5*) and three pairs of gland openings (*gd2*, *gd4* and *gd8*). Muscle marks visible, mainly on podosomal areas between *j3* and *j6*. Peritremes extending forward to

bases of *j1*. Lengths of setae: *j1* 15, *j3* 26, *j4* 14, *j6* 21, *z2* 32, *z4* 39, *z5* 9, *s4* 131 *J2* 33, *J5* 8, *Z1* 18, *Z4* 126 *Z5* 144, *S2* 38, *S4* 18, *S5* 17, *r3* 8, *R1* 11.

Ventral idiosoma (Fig. 5B, Plate 4B). Sternogenital shield reticulated throughout, anterior margin strongly and squarely emarginated between first pair of sternal setae; posterior margin nearly straight, bearing five pairs of attenuate setae (*st1*, *st2*, *st3*, *st4* and *st5*) and three pair of lyrifissures (*iv1*, *iv2* and *iv3*), shield 119 long from middle of anterior margin to posterior margin, 90 wide. Lengths of setae: *st1* 24, *st2* 20, *st3* 17, *st4* 18, *st5* 32. Ventrianal shield approximately subquadrate (although weakly tapering and rounded posteriorly), anterior margin with a medial flange, reticulated throughout, 239 long, 203 wide (at widest level), with three pairs of pre-anal setae (*JV1*, *JV2* and *ZV2*; *JV3* and *ZV3* absent), a pair of para-anal seta (*pa*) and a postanal seta (*po*); one pair of small pores on anterior margin of ventrianal shield, another pair of small pores on lateral margin level with *JV1*. A pair of small circular gland openings (*gv3*) posteromediad of *JV2*, distance *gv3–gv3* 27. Setae *JV5* on cuticle surrounding ventrianal shield. Lengths of setae: *JV1* 41, *JV2* 45, *ZV2* 14, *JV5* 15.

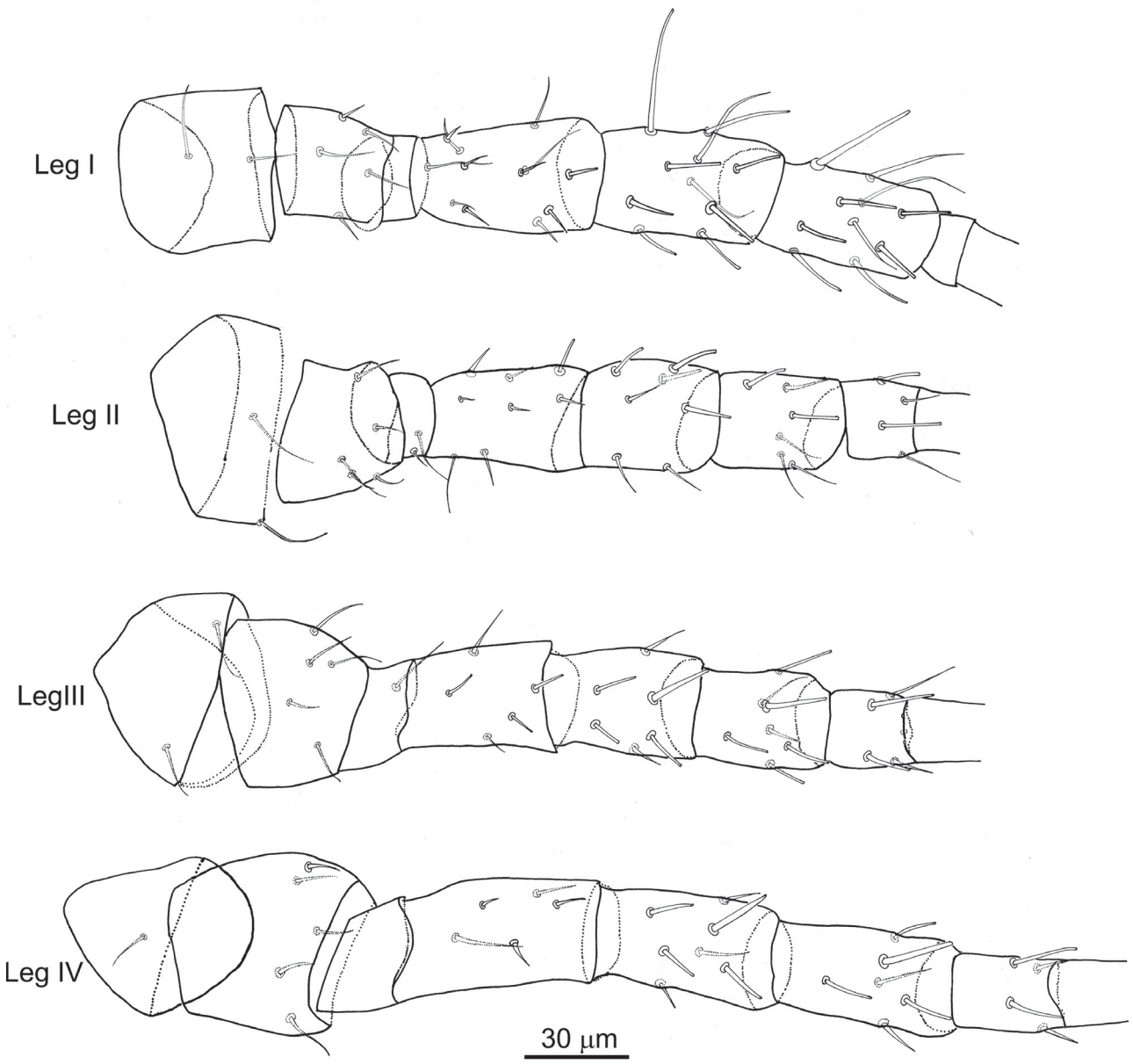

FIGURE 6. *Phytoscutus acaridophagus* (female). Legs I–IV.

Gnathosoma (Fig. 5C, Plate 4C). Spermatodactyl L-shaped, small, with round heel and straight foot.

Specimens examined: 2 females, Piha South, Auckland, ex. *Piper excelsum* (Piperaceae), 30 September 2016, coll. Nicholas Martin (T16_03282). 2 females, 1 male, Lake Waikaremoana, ex. *Rubus* sp. (Rosaceae), 20 April

1965, collector unknown. 2 females, Abel Tasman National Park, ex. *Microsorum scandens* (Polypodiaceae), 14 July 1966, collector unknown, Nelson.

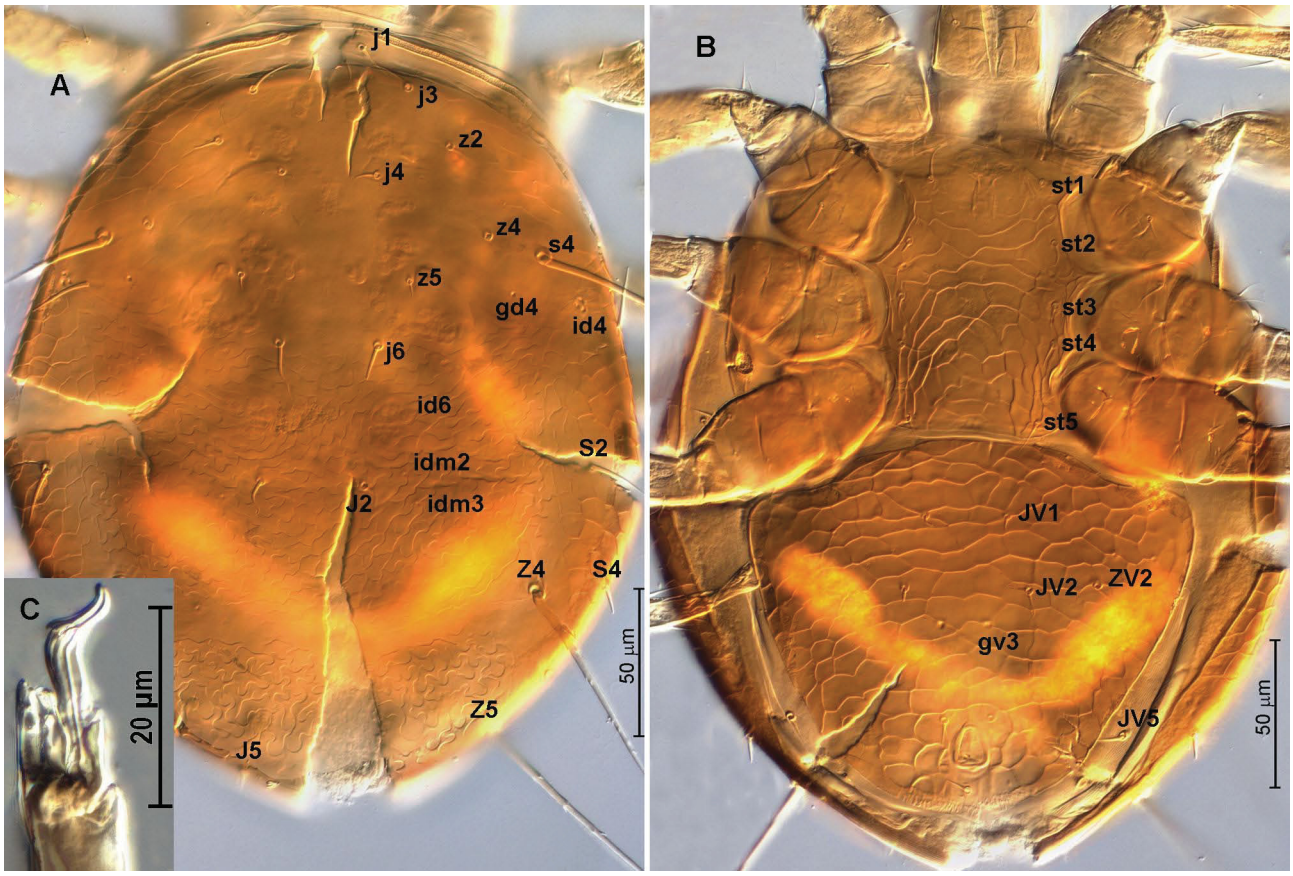

PLATE 4. *Phytoscutus acaridophagus* (male). A. dorsal view of idiosoma; B. ventral view of idiosoma; C. spermathecal.

Distribution. New Zealand: Auckland (Collyer 1964; this paper), Gisborne (Collyer 1966), Nelson (Collyer 1966). Australia: New South Wales (Yoshida-Shaul & Chant 1997), Queensland and Victoria (Walter 1999).

Remarks. The species was first described based on a single male which was designated as the holotype by Collyer (1964). Two years later Collyer (1966) described the female based on the subsequent collections and also provided the collection data of seven females, two males, unknown number of immatures. She treated one female as the allotype and the rest as paratypes; however, these are not type specimens, which must be designated in the original description.

We found that the movable digit on our specimens bears two teeth, and the fixed digit has six teeth in females of this species. Although Collyer (1966) did not specifically state the number of teeth on the chelicerae, her illustration indicated two teeth on the movable digit and four teeth on fixed digit; and Walter (1999) mentions two teeth on the movable digit. Yoshida-Shaul & Chant (1997) did not describe the number of teeth on chelicerae in the redescription.

Genus Proprioseiopsis Muma

Proprioseiopsis Muma, 1961: 277.
Type species: *Typhlodromus* (*Amblyseius*) *terrestris* Chant, 1959: 108

Proprioseiopsis lenis (Corpuz & Rimando, 1966)

Amblyseius lenis Corpuz & Rimando, 1966: 118.
Proprioseiopsis sullivani Schicha & Elshafie, 1980: 34. Synonymy Schicha & Corpuz-Raros 1992.

Redescription

Adult female (n=3 from New Zealand plus holotype and one paratype from Australia).

TABLE 3. Comparative measurements (in micrometres) of females of *Proprioseiopsis lenis* (Corpuz & Rimando, 1966).

Characters	Original description by Corpuz & Rimando, 1966	*Proprioseiopsis sullivani* Schicha & Elshafie, 1980		NZ material (this study)
		Original description	Holotype & paratype, this study	
Dorsal shield (L)	862	312–322	328–348	344–364
Dorsal shield (W)	232	180–186	230–231	209–232
j1	22	20–23	21–23	20–21
j3	29	28	29–30	25–30
j4	–	4–6	5	5–6
j5	–	4–6	5	4–6
j6	–	4–6	6	7
z2	–	12–15	13	14–16
z4	–	10–14	9	10
z5	–	4	5	4–5
s4	58	54–59	59–69	57–61
J5	–	8–9	10	8–11
Z1	–	6–7	7	7–8
Z4	80	71–74	71–73	77
Z5	73	110–112	110–111	121
S2	–	9	8	9–10
S4	–	8–10	9	9–11
S5	–	8–10	9	8–12
r3	–	12–14	13	10–15
R1	–	8–11	9	9–12
Sternal shield (L)	As wide as long	57–58	68	70–73
Sternal shield (W)	As wide as long	69–70	75	77
Distance *st5–st5*	–	–	72	69–72
st1	–	–	26	29–30
st2	–	–	25	27–28
st3	–	–	23	24–25
st4	–	–	23	24
st5	–	–	23	23–26
Ventrianal shield (L)	–	105–110	109	111–116
Ventrianal shield (W)	–	93–95	98	94–99
Distance *gv3–gv3*	–	11–14	16	16
JV1	–	–	15	15–17

...Continued on next page

TABLE 3. (Continued)

Characters	Original description by Corpuz & Rimando, 1966	*Proprioseiopsis sullivani* Schicha & Elshafie, 1980		NZ material (this study)
		Original description	Holotype & paratype, this study	
JV2	–	–	15	16–17
JV4	–	–	14	14
JV5	–	–	63	66–77
ZV1	–	–	15	14–16
ZV2	–	–	14	16–17
ZV3	–	–	14	13–14
Primary metapodal platelets (L)	–	–	22	12–14
Primary metapodal platelets (W)	–	–	7	2–3
Secondary metapodal platelets (L)	–	–	11	12–25
Secondary metapodal platelets (W)	–	–	3	3–4
Spermathecal cervix	–	8 wide	–	5–8
Movable digit	–	32	32	29–30
Pilus dentilis	–	–	8	30–35
Leg I 399	–	–	353	381–383
Leg II 338	–	–	279	289–295
Leg III 336	–	–	298	289–294
Leg IV 419	–	–	383	391–393
Macroseta Ge IV	46	45–48	48–49	49
Macroseta Ti IV	24	25–28	27–29	29–31
Macroseta BTa IV	55	52–57	62	61–64

Dorsum (Fig. 7A, Plate 5A). Dorsal shield smooth, with sparse lateral striation, nearly oval, with waist at level of *R1*; 357 (344–364) long, 220 (209–232) wide at level of setae *s4*, bearing 16 pairs of smooth setae, except *Z5* slightly barbed, with 16 pairs of setae, five pairs long (*s4*, *z2*, *z4*, *Z4*, *Z5*) but others minute (Fig. 7A); *s4* longer than other pronotal setae, *j3* slightly longer than *j1*, reaching base of *j1*; *z2* longer than *z4*, more than half as long as distance between *z2* and *z4*; *Z5* longest dorsal setae, less than twice as long as *Z4*. Lateral setae *r3* and *R1* smooth, on soft membranous cuticle lateral to dorsal shield, *r3* at level of *z4*. Sixteen pairs of lyrifissures visible (*id1*, *id2*, *id4*, *id6*, *idl1*, *idl3*, *idl4*, *idla*, *is1*, *idm1–6* and *idx*) and six pairs of gland openings (*gd2*, *gd4*, *gd5*, *gd6*, *gd8* and *gd9*) present on dorsal shield. Muscle marks visible, mainly between *j1* and *Z4*. Peritremes extending forward and reaching base of *j1*. Lengths of setae: *j1* 21 (20–21), *j3* 28 (25–30), *j4* 5 (5–6), *j5* 5 (4–6), *j6* 7, *z2* 15 (14–16), *z4* 10, *z5* 5 (4–5), *s4* 58 (57–61), *J5* 10 (8–11), *Z1* 8 (7–8), *Z4* 77, *Z5* 121 (117–124), *S2* 9 (9–10), *S4* 10 (9–11), *S5* 10 (8–12), *r3* 13 (10–15), *R1* 10 (9–12).

Ventral idiosoma (Fig. 7B, Plate 5B). Sternal shield slightly reticulated, 72 (70–73) long, 77 wide at level of *st2*, middle of anterior margin concave, posterior margin straight, bearing three pairs of setae (*st1*, *st2* and *st3*) and two lyrifissures (*iv1* and *iv2*); *iv1* posterior to *st1*, *iv2* anterior to *st3*; *st4* and *iv3* on metasternal platelets. Genital shield smooth, anterior of shield faint, posterior margin slightly narrower than the ventrianal shield, bearing a pair of setae *st5* and three pairs of genital sigillae, distance between *st5–st5* 70 (69–72), a pair of poroids between *st5* and *ZV1*. Lengths of setae: *st1* 30 (29–30), *st2* 27 (27–28), *st3* 24 (24–25), *st4* 24, *st5* 25 (23–26). A series of horizontal sclerites present between genital and ventrianal shields, a pair of genital sigillae located at anterior corners of shield.

Ventrianal shield reticulate (Plate 5E), 113 (111–116) long, 96 (94–99) wide at level of *ZV2*, approximately pentagonal, with three pairs of pre-anal setae (*JV1*, *JV2* and *ZV2*) and a pair of pores *gv3* mediad to *JV2*, distance *gv3–gv3* 16; four pairs of setae (*ZV1*, *ZV3*, *JV4* and *JV5*) and four pair of lyrifissures on soft cuticle surrounding ventrianal shield; *JV1* at anterior margin of ventrianal shield. Lengths of setae: *JV1* 16 (15–17), *JV2* 17 (16–17), *JV4* 14, *JV5* 71 (66–77), *ZV1* 15 (14–16), *ZV2* 16 (16–17), *ZV3* 13 (13–14). Primary metapodal platelets 13 (12–14) long, 2 (2–3) wide, secondary metapodal platelets 13 (12–25) long, 4 (3–4) wide.

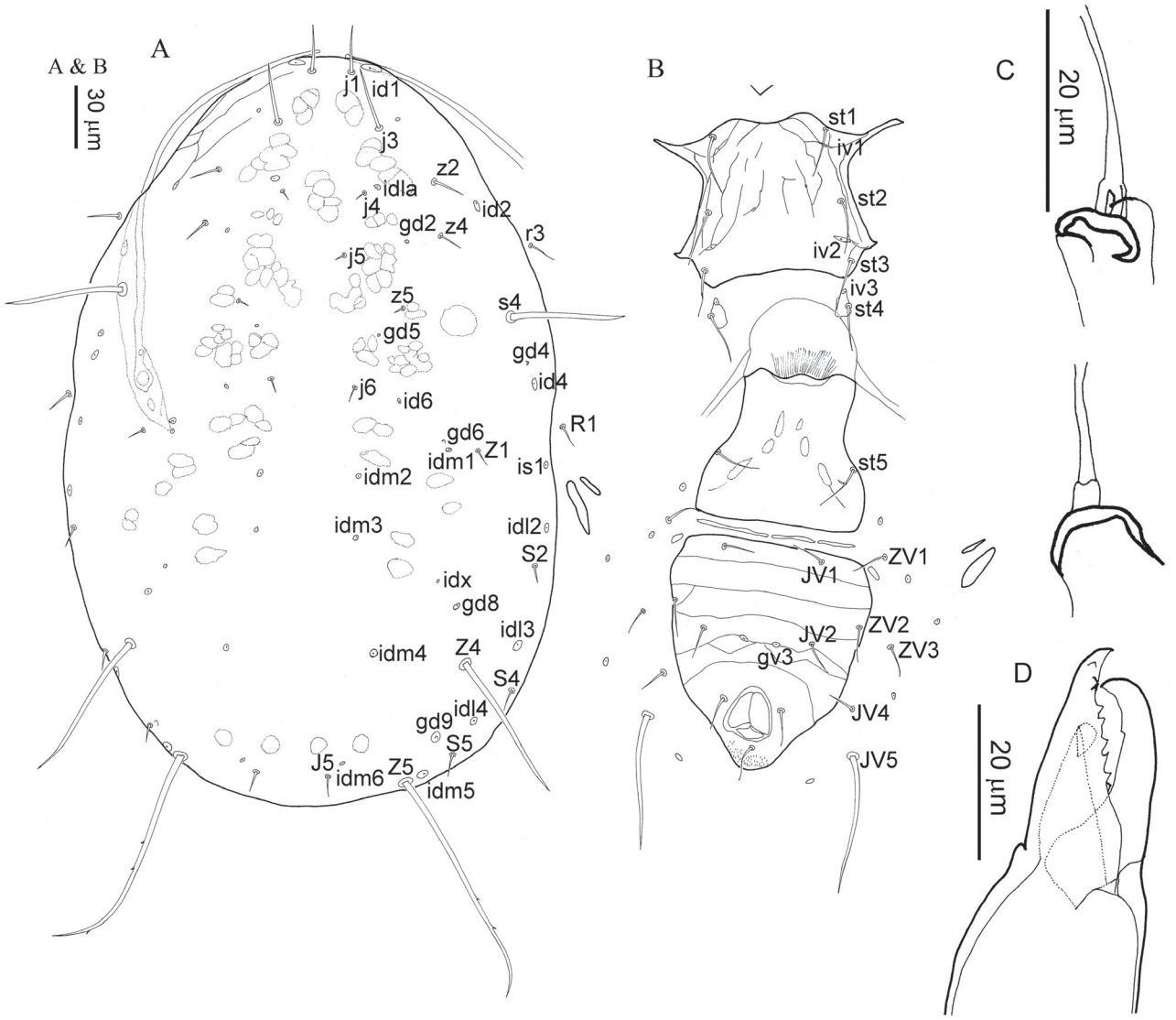

FIGURE 7. *Proprioseiopsis lenis* (female). A. dorsal idiosoma; B. ventral idiosoma; C. insemination apparatus. D. chelicera.

Spermatheca (Fig. 7C, Plate 5D): atrium large, incorporated into base of calyx, major duct faint, long and slightly narrower than atrium; minor duct slender; cervix shallow cup-shaped, 5 (5–8) long.

Gnathosoma. Chelicera (Fig. 7D, Plate 5C) with movable digit 30 (29–30) long, bearing one tooth, fixed digit 35 (30–35) long, bearing 8–9 teeth, pilus dentilis 6 long and located between fourth and fifth teeth.

Legs (Fig. 8). Leg I 382 (381–383), chaetotaxy (coxa to basitarsus): 0-0/1-0/1-0; 1-1/2-0/0-1; 2-3/2-2/1-2; 2-2/1-2/1-2; 2-2/1-2/1-2; 0-0/0-0/0-0 respectively. Leg II 293 (289–295); chaetotaxy: 0-0/1-0/1-0; 1-0/1-0/1-1; 1-2/1-1/1-1; 1-2/1-2/0-1; 1-1/1-2/1-1; 1-1/0-1/0-1. Genu with one macroseta, 24 (23–24) long. Leg III 291 (289–294); chaetotaxy: 0-0/1-0/1-0; 1-1/1-0/1-1; 1-2/1-1/0-1; 1-2/1-2/0-1; 1-1/1-2/1-1; 1-1/0-1/0-1; Genu with one macroseta, 24 (24–25) long. Leg IV 393 (391–393); chaetotaxy: 0-0/1-0/0-0; 1-1/1-0/1-0; 1-2/1-1/0-1; 1-2/1-2/0-1; 1-1/1-2/1-0; 1-1/0-1/0-1. Genu, tibia and basitarsus each with one stout and blunt-tipped macroseta, *Sge IV* 49, *Sti IV* 31 (29–31), *St IV* 61 (61–64).

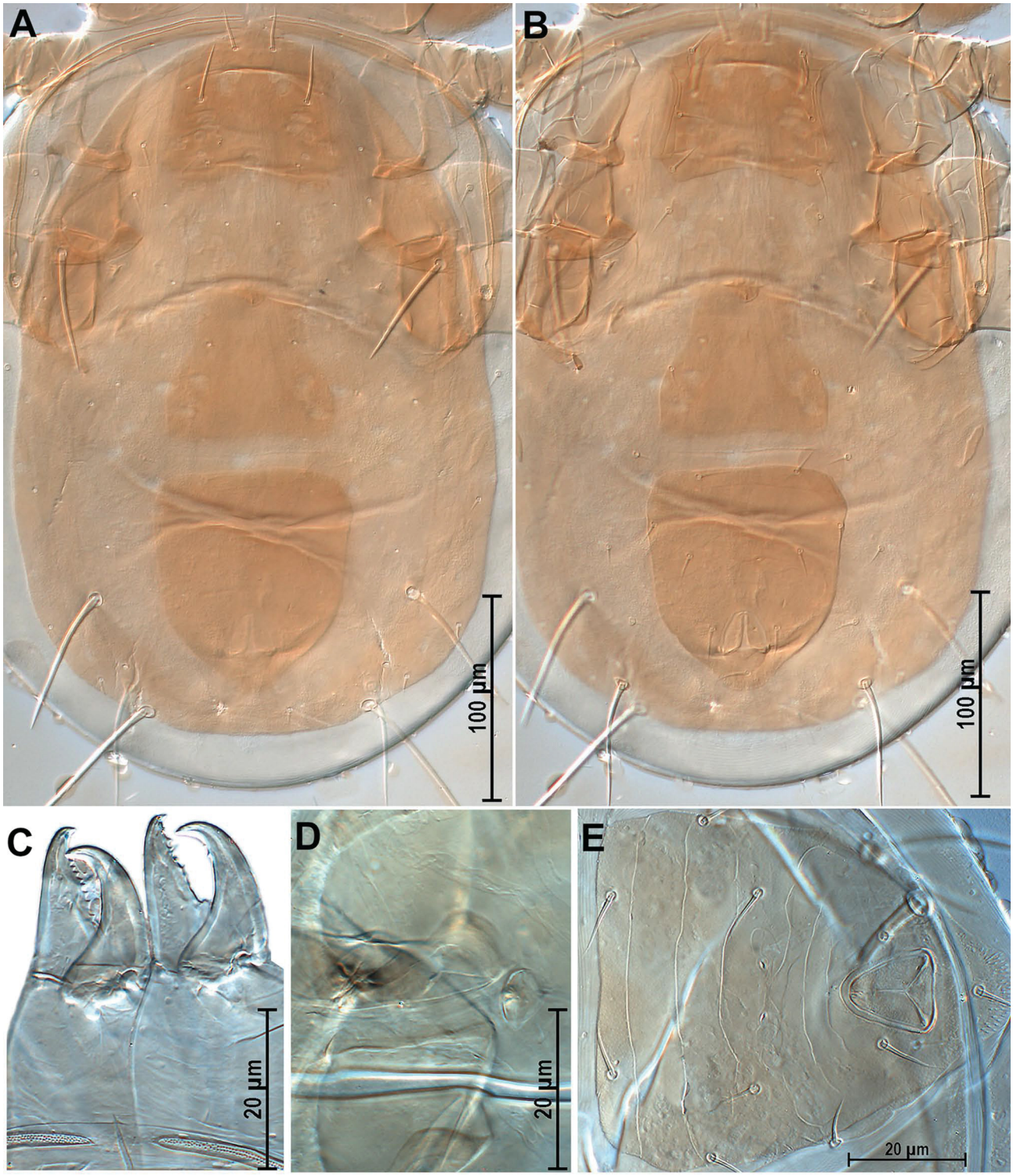

PLATE 5. *Proprioseiopsis lenis* (female holotype). A. idiosoma (dorsal view); B. idiosoma (ventral view). C. Chelicerae. D. spermatheca; E. Ventrianal shield.

Adult male. Not seen.

Specimens examined: New Zealand: 4 females, Helensville greenhouse, Auckland, ex. *Capsicum annuum* (Solanaceae), 31 August 2000, coll. P. Workman; Malaysia: 10 females, Serdang, ex. a lab colony, 12 October 2001, coll. Z.-Q. Zhang. AUSTRALIA, QUEENSLAND: holotype female + 1 paratype female (as *A. sullivani* in ASCU, previously BCRI; ASCT00029283) on strawberry, Redland Bay, 26 February 1976, L. Markwell.

Distribution. Australia (Corpuz-Raros 2005 (as *A. sullivani*); Schicha 1987 (as *A. sullivani*); Schicha & Elshafie 1980 (as *A. sullivani*)); **Malaysia**: Serdang (this paper); **New Zealand** (Auckland, this paper); **Philippines** (Corpuz-Raros 1994, 2005; Corpuz & Rimando 1966; Schicha & Corpuz-Raros 1992); **Thailand** (Oliveira *et al*. 2012).

Remarks. *Proprioseiopsis lenis* is recorded from New Zealand and Malaysia for the first time. We have noted and illustrated the following characters which were not presented in the original publication (Corpuz & Rimando 1966): lyrifissures, solenstomes and muscle marks on idiosoma, sternal shield and legs I–III. Our specimens of *P. lenis* were collected on *Capsicum annuum*. This species has been collected from over 60 species of plants including ornamentals, vegetables, fruit crops and weeds, also from the leaf litter associated with many plants, especially rice hay (Corpuz-Raros 2005). In our slides, we also observed some specimens with nine teeth on the fixed digit. We noted that setae *Z*5 were slightly longer in NZ specimens (121) than in Australian material (110–112); they are much shorter in specimens described from the Philippines (73). We here follow Schicha & Corpuz-Raros (1992) in considering this as intraspecific variation.

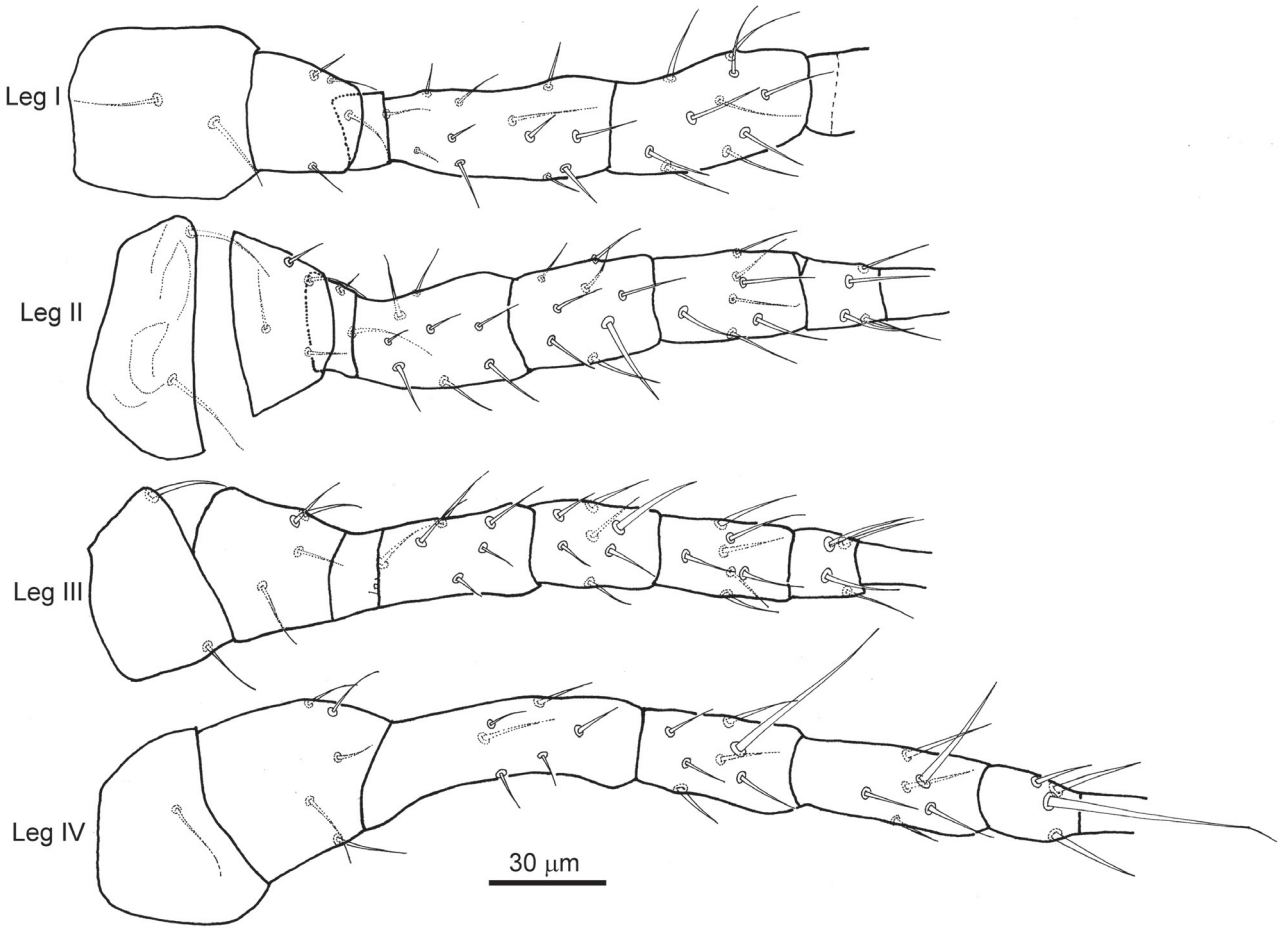

FIGURE 8. *Proprioseiopsis lenis* (female). legs I–IV.

Key to New Zealand species of *Proprioseiopsis* (female)

1. Cervix bell-shaped, about 3× as long as its basal width; *gv3* posterior to *JV2* . . . . . *P. messor* (Wainstein, 1960)
- Cervix shallow cup-shaped, as long/deep as its basal width; *gv3* nearly medial to *JV2* . . . .*P. lenis* (Corpuz & Rimando, 1966)

Note

We agree with Schicha (1987) and Minor (2003) that *Amblyseius mexicanus* (Garman, 1958) sensu Collyer (1964; 1982) is a junior synonym of *Proprioseiopsis messor* (Wainstein, 1960). We re-examined the specimens of *Proprio-*

seiopsis exopodalis recorded by Collyer (1964) and found that it was actually a member of the genus *Graminaseius*. Therefore, there are only two species of *Proprioseiopsis* in New Zealand. With *Graminaseius exopodalis* (Kennett, 1958) comb. nov., the genus *Graminaseius*—previously not recorded in New Zealand—now has three species in New Zealand.

Acknowledgements

We are grateful to Chris Winks (Manaaki Whenua Landcare Research) for collecting specimens, and two anonymous reviewers for constructive comments. We also thank Dr Danuta Knihinicki (ASCU) for the loan of type specimens from her collection. The senior author appreciates the financial support from China Scholarship Council and thanks Prof. Sheng-cai Li (Shanxi Agriculture University) for the encouragement and support provided to her. Zhi-Qiang Zhang was supported by New Zealand Government core funding for Crown Research Institutes from the Ministry of Business, Innovation and Employment's Science and Innovation Group.

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